

MARINE SAFETY MANUAL

- 3.E.2.a (6) (cont'd) designed with a "design margin" or "factor of safety" approach. However, as more is learned about design and material parameters, engineering and economic considerations will lead to increased use of refined analytical and experimental design procedures. Coast Guard engineers must keep abreast of factors affecting pressure vessel design, since they will be increasingly called upon to evaluate designs that more fully use material properties and advanced design methods.

b. Propulsion Boilers.

- (1) Introduction. The importance of reliability in vessel propulsion becomes obvious as one considers the consequences of losing the main propulsion plant. The design effort devoted to reliability has been receiving increased emphasis in recent years due to growing complexity of equipment and the trend toward reduced manning. The cost of taking ships out of service for repairs has also increased the attention given to designing for reliability and maintainability. Although many operators consider two boilers necessary to ensure propulsion for the vessel in case one boiler is lost, the Coast Guard does not prohibit single boiler installations.
- (2) General Requirements. Certain characteristics are important in marine boilers. It is desirable to keep the size of these components to a minimum to maximize availability of vessel cargo space. The center of gravity should be low to increase vessel stability. Boiler drums should be arranged fore-and-aft to minimize sloshing and water level control problems. Foundations must be designed to withstand loads from ship motions. Access must be carefully provided for inspections and repairs. Combustion controls must be suitable for shipboard service, which makes components such as mercury switches unacceptable. Special piping requirements help provide reliable supplies of fuel and water. Manning and automation requirements for boiler installations are geared to the increased attention required by boilers, as opposed to diesel installations. Marine boilers are designed for more potentially harmful vibration and shock loading than are shore-based boilers. These examples give some feel for special considerations relating to marine boilers and, when coupled with failure consequences typically more serious than for land-based boilers, point to the need for particular interest in reliability and safety.
- (3) Main Boiler Safety Valves. The design, sizing, setting, and repair of main boiler safety valves are extremely important. The required safety valve capacities are based on the boiler overload ratings determined during design of the boilers. Re-heaters, air heaters, economizers, boiler design characteristics, and type of fuel affect these capacities. ASME does not certify or approve safety valves. When requested by ASME, the National Board of Boiler and Pressure Vessel Inspectors (NB) will survey a manufacturer's facility, valve designs, quality control systems, and flow test facility to establish valve capacity in accordance with the ASME Code. Capacity test data for each valve model, type, and size signed by the manufacturer and an authorized observer is submitted to the NB for certification. Certificates

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- 3.E.2.b (3) (cont'd) must be renewed every 3 years. Valves certified by the NB are published in "Relieving Capacities of Safety Valves and Relief Valves Approved by the National Board," which includes relieving capacity data. Many considerations affect selection of safety valve set pressures and blowdowns. Improperly set valves can result in overpressure or overheating of the boiler, simmer, chatter, rapid cycling, frequent operation, or deterioration of the safety valves. Parts 67-73, Section I of the ASME Code contain a wealth of information on safety valves, some of which Coast Guard inspectors should know. For example, for service over 250 psig the tolerance on setting a valve is ± 5 percent of the pressure marking on the valve. The setting of superheater safety valves may depend upon the pilot valve setting, the design pressure of the superheater, or the design pressure of the main steam piping.

Safety valves are repaired under the provisions of 46 CFR 59.01-5. Due to a previous history of unsatisfactory repairs, Repair Of Boiler Safety Valves", COMDTPUB P16700.4, NVIC 1-71, was written to set forth procedures by which the Coast Guard can accept repaired valves as equivalent in performance to that of a new valve (see below concerning the National Board).

- (4) Superheaters. Of particular concern in the approval and inspection of boilers are the steam and tube metal temperatures of superheaters. Depending on the design and arrangement of superheater tubes and headers, steam temperatures in some parts of the superheater can be substantially higher than those in the superheater outlet. Tube metal temperatures also vary throughout the superheater. Highly sophisticated techniques of analysis and much experience go into predicting what these temperatures will be; these temperatures rarely turn out exactly as predicted, due to all the variables involved. For this reason, it is normal practice to outfit the first boiler in a class of vessels with thermocouple temperature monitoring systems. It is important to know what these temperatures actually are, because at high temperatures, temperature increases can result in tremendous loss of strength in the metal. Temperature increases of 250°F may result in reductions in material allowable stress of 25 percent or more, depending on the actual temperature and material. Concern for this delicate balance between temperature and allowable stress does not end with the boiler. The main steam piping from the boiler must be similarly designed for the high steam temperature. This is done by selecting appropriate allowable stress values to maintain required safety factors for pressure containment in keeping thermal expansion stresses at an acceptable level. This points to the importance of the requirement in 46 CFR 52.01-95(b)(2) for visible and audible alarms to indicate excessive superheat. All boilers with integral superheaters are approved for a maximum allowable superheater outlet temperature. For protection of both the superheater and the main steam piping, the alarm setting should not exceed this approved temperature. Recently, boiler fuel rates have become an important consideration, resulting in a trend to operate very close to the maximum allowable temperature to improve efficiency.